This invention relates to a connector device for making electrical connection in a conductive liquid environment. The device consists of two portions, the first portion including a liquid containing tubular housing closed at one end. A first tubular contact element of less diameter and length than the housing is coaxially supported at one end within said tubular housing, and a second tubular contact element of less diameter and length than the first tubular contact element is coaxially supported at one end in the tubular housing. A rupturable membrane normally closes the open end of the tubular housing and the housing is filled with a nonconductive liquid. The other portion of the connecting device includes a vertical first contacting element of an elongated cylindrical configuration having means at one end for engaging and puncturing the rupturable membrane. An insulating sleeve surrounds all but the engaging portion of the cylindrical element and the tubular second contacting element of length less than the cylindrical element is coaxially received about the insulating sleeve. The device is configured to make electrical connection in a liquid environment by moving one or the other of the portions vertically to contact the other, in the arrangement wherein the rupturable membrane is punctured and the second connecting member extends within the tubular housing of the first member, so that the second element of the first member engages the exposed end portion of the second member cylindrical element and in like manner the second contacting element of the second member engages the first tubular contacting element of the first portion, both of the contacting elements of each member being surrounded by the nonconductive liquid.

This application is a continuation of Ser. No. 483,171, filed Aug. 27, 1965, and now abandoned.

This invention relates to a submersible electrical connector. More particularly, the invention relates to a device for connecting and disconnecting an electrical circuit submerged in a liquid. Still more particularly, the invention relates to a device particularly adapted for use in an oil or water well for connecting and disconnecting an electrical circuit, the device being useful for connecting and disconnecting a circuit in a corrosive fluid such as salt water or the like.

Many types of devices used in the drilling and mining industries require electrical connections to be made in the bottom of a well. Frequently these connections must be made in liquid such as salt water, which is highly corrosive and also highly conductive. Because of the extreme difficulty experienced in previously utilized devices for making underwater electrical connections, many types of devices utilized in the bottom of wells depend upon the running of electrical connectors into and out of the well to avoid the necessity for making connections in the well itself. For instance, bottom hole centrifugal pumps are frequently utilized in the oil industry. These pumps may be located to depths up to five thousand feet. The present method of installing such a pump is to affix the pump to the bottom of a tubing and run the pump into a casing by installing sequential links of tubing. At the same time, a conductor attached to the pump motor is run concurrently with the tubing and attached to the outside of the tubing. This means that extra labor must be employed to run a submersible centrifugal pump in or out of the well since the conductors must be handled at the same time the tubing is handled.

This invention provides in one of its applications a means which eliminates the present requirement that the electrical conductor must be run into the well concurrently with a bottom hole pump and provides instead a device which permits the pump or other electrical device to be first run into the well and electrical connection to be made subsequently.

It is therefore an object of this invention to provide a device for making a submerged electrical connection.

Another object of this invention is to provide a device for connecting and disconnecting an electrical circuit in a liquid environment.

More particularly, an object of this invention is to provide a device for making and disconnecting an electrical circuit in a liquid environment wherein the liquid is either corrosive, conductive, or both, the device being arranged such that corrosive or conductive liquids are prevented from contacting the electrical contact portions of the device.

Another object of the invention is to provide a device for connecting and disconnecting a pump or similar electrical device, as utilized in oil or water wells.

These and other objects and a better understanding of the invention may be had by referring to the following description and claims taken in conjunction with the attached drawings in which:

FIGURE 1 is an exploded cross-sectional isometric view of the elements of the connector of this invention in non-contact relationship.

FIGURE 2 is a cross-sectional isometric view similar to that of FIGURE 1, but showing the elements in contact relationship.

FIGURE 3 is a cross-sectional view showing an application of the submersible connector of this invention as utilized to connect a bottom hole pump.

FIGURE 4 is a cross-sectional view taken along the line 4-4 of FIGURE 3.

FIGURE 5 is a cross-sectional view taken along the line 5-5 of FIGURE 3.

FIGURE 6 is an external view of the connector of this invention showing the elements in disconnected relationship.

This invention may be described as a connector for making electrical connections in a fluid environment. More particularly, but not by way of limitation, the invention may be described as a device for making electrical connections in a fluid environment consisting of a first portion having a tubular housing closed at one end and open at the other end with insulated contacting elements within the first portion housing, a replaceable rupturable membrane closing the open end of the first portion tubular housing providing a fluid tight enclosure which is filled with a noncorrosive and nonconductive liquid, a second portion telescopically extendable within the first portion, the second portion having insulating contacting elements which engage the contacting elements of the first portion when the second portion telescopically extends within the first portion, the second portion having means at the end for rupturing the membrane as it telescopically extends within the first portion.

Referring now to the drawings and first to FIGURES 1, 2 and 6, the basic connector of this invention is shown. The connector consists of two basic portions, that is, a first portion, generally indicated by the numeral 10, and a second portion, generally indicated by the numeral 12. The
3,398,392

3 first portion 10 may be considered in the nature of female portion and the second portion 12 the male portion. The first portion 10 includes a tubular housing 14 which is closed at one end and open at the other. The housing 14 includes two axial, tubular insulated contacting elements 16 and 18, the element 16 being longer and larger in diameter compared with the element 18. The end of both of the contacting elements 16 and 18 adjacent the open end of the housing 14 are provided with slits 20 so as to provide spaced resilient contacting tangs 22 each extending parallel to the housing axis. The long contacting element 16 is insulated from the housing 14 by means of the tubular insulator 24. An insulated 26 closes the end of contacting member 16, and thereby the end of housing 14 and provides a base for the support of contacting member 18. In this manner it can be seen that the contacting members 18 and 16 are coaxially supported and spaced in insulated relationship relative to each other. The arrangement is by way of example. It can be seen that either of the contacting members 16 and 18 could be in continuity with housing 14.

The contacting element 18 is closed at one end and has an axially extending threaded portion 28 which extends forwardly from the housing 30 in the insulator 26. A nut 32 threadably receives the threaded portion 28. In the embodiment shown the rod 32 serves as one of the conductors to the first portion 10. The second conductor 34 is in continuity with contacting element 16 by means of screw 36.

Screws 38 extend through housing 14, through cylindrical insulating member 24 and through openings 40 in the conducting element 16, to threadably engage the insulator 26.

The open end of housing 14 is closed with a rupturable membrane 42. While this may be in various forms, an inexpensive embodiment of the rupturable membrane 42 consists simply in the use of a small piece of thin rubber positioned over the open end of the housing 14 and extending back along each side of the housing. The membrane 42 is held in place by a rubber band 44. The rupturable membrane 42 makes housing 14 a liquid type enclosure for purposes to be hereinafter described.

The membrane 42 may be of plastic film or any other rupturable material. However, thin rubber, such as dental dam rubber, is preferred since when it is punctured, it snaps to completely expose the open end of the tubular housing 14 and does not leave extending fragments.

The second portion 12 of the invention consists of an elongated substantially cylindrical contacting member 46 which is configured at one end 50 to engage and rupture the membrane 42 of the first portion 10. The contacting member 46 has a reduced diameter threaded portion 52 at the end opposite the punch end. An insulating cap 54 is axially received by the threaded portion 52. Positioned around the contacting member 46 is a tubular insulator 56 and positioned over the insulator 56 is a second contacting member 58 which, in the embodiment illustrated, is tubular. A conductor 60 is in continuity with contacting member 46 by means of nut 62. Second conductor 64 extends through the insulator 54 to provide continuity with second conducting member 58.

Referring to FIGURE 6, the first and second portions including the connector of this invention are shown in disassembled external view. The connector is shown in the attitude ready for making electrical connections in a liquid environment. The second portion is normally fixed and the first portion is moved towards the second portion in the liquid environment to afford contact. The first portion 10 is a sealed enclosure which, in the preferred application of the invention, is filled with some fluid which is non-conductive to the contacting elements making up the connector and which, at the same time, is nonconductive. In the typical application of the connector of this invention the second portion 12 is affixed within the liquid environment and the first portion 10 is moved toward it to afford contact. In this preferred embodiment wherein the first portion 10 is moved downwardly through the liquid environment to contact the second portion 12 the liquid filling the first portion 10 is preferably of a specific gravity less than the liquid constituting the environment in which the connection is made.

Referring to FIGURES 3, 4 and 5 an application of the submersible connector of this invention is illustrated. As previously indicated, one of the primary applications of the invention is its use to connect electrical circuits to devices utilized in the bottom of wells. FIGURE 3 is a cross-sectional view of a string of casing positioned in the earth. An electrical powered centrifugal bottom hole pump 68 is supported within the casing at the end of a string of tubing 70. In present practice the bottom hole pump 68 is connected to an electrical source at the earth's surface by a means of a cable which extends from the pump to the surface along the exterior of tubing 70. This invention provides a means of connecting and disconnecting electrical contact from the pump 68 without the necessity of attaching an electrical cable to the exterior of the tubing 70 and in a manner such that the electrical conductor does not have to be installed concurrently with the running of the pump into the well.

Pump 68 typically includes an electric motor 72 which drives a centrifugal pump 74. Fluid enters the pump through openings 76 and is forced up through the interior of the tubing string 70 to the earth's surface. Utilizing the invention of the disclosure the second portion 12 of the connector is positioned uprightly on a base plate 78, within tubing 70, the base plate being provided with a multiplicity of openings 80 so that fluid forced upwardly by the pump 74 can pass therethrough. Conductors 82 connect the second connector portion 12 with the motor 72 and are sealed at 84 to prevent the escape of fluid.

A short length of tubing 86 constituting in effect, a portion of the string of tubing 70 is connected to the tubing string 70 by a coupling 88. The short length of tubing 86 functions primarily as a support for the second connector portion 12. While in the drawing, the tubing 86 is shown of reduced diameter, it may be of the same diameter as the pump 68 so that openings 80 in base plate 78 do not restrict fluid flow.

To provide electrical connection such as for means of supplying power to the pump 68 the first connector portion 10 is lowered within the tubing 70 from the surface to engage the second connector portion 12. In this application the rod 32 to which the first connector portion 10 is affixed is relatively long for two purposes, that is, first, to provide means of accurate axial alignment within the tubing 70 and, second, to afford weight to carry the first connector member 10 downwardly through the tubing 70 and into firm contact with the second connector portion 12. Affixed to the rod 32 are spaced centralizers 90 which are typically of spring steel to resiliently align the first connector portion 10 coaxially within the tubing 70. Conductor 34 and a conductor 92 affixed to the rod 32 provides electrical continuity of the first connector portion 10 to the earth's surface. Although not shown, an obvious addition would be the inclusion of a cable affixed to the end of rod 32 with the conductors 92 and 34 attached to it providing the strength necessary to lower and raise the connector portion 10 into and out of the tubing 70.

Utilizing the coupling of this invention it can be seen that when pump 68 is run into the hole in casing 66, only the tubing string 70 is utilized. No extra labor and equipment are required to simultaneously run the necessary electrical connectors to supply power to the pump. After the pump has been positioned within the well, electrical connections are supplied by lowering within the tubing 70 the first connector portion 10. The centralizers 90 axially align the coupling so that it engages the upstanding second coupling portion 12 and telescopically receives it to pro-
vide electrical continuity between the surface and the pump.

Most oil wells contain quantities of salt water and other corrosive and highly conductive liquid. Even the water in most water wellbore is conductive. This has presented a substantially insurmountable problem to previous attempts to provide electrical connectors for connecting electrical sources in such a liquid environment. In this invention the first connector portion 10, preparatory to introduction into the tubing 70 while still at the earth's surface, is filled with a non-conductive and non-conductive liquid which is preferably of a lower specific gravity than the liquid contained within the well. After the housing 14 is filled with liquid the membrane 42 is placed over the end of the housing and held in place with rubber band 44. As the first connector portion 10 is lowered into the well the protective fluid is retained within the housing 14. Upon reaching the second connector portion 12 the membrane 42 is ruptured. By the selection of a protective fluid filling the first port 10 having a lower specific gravity than the fluid of the well the rupture of the membrane 42 will not result in the protective fluid leaving the confines of the first connector portion. As the second connector portion telescopically enters the first portion of the protective fluid is displaced outwardly which tends to wash the second portion 12. The nondisplaced part of the fluid which remains within the housing 14 when the second portion is fully telescopically received continues to provide a noncorrosive and non-conductive effect as long as the connection is maintained.

When it is desired to remove the pump 68 from the well electrical connection can first be moved by withdrawing the first connector portion 10 by pulling upwardly on conductors 92 and 34. If desired, the first conductor portion 10 can be rerun into the well, the requirements being that before rerunning the housing 14 filled with protective fluid the membrane 42 is positioned in place. It can be seen that the membrane 42 serves only to retain the protective fluid in place during entrance into the well. By selecting a protective fluid having a specific gravity less than the fluid in the well, the protective fluid will remain within the housing 14 even after the protective membrane has been ruptured once the housing 14 is submerged in the well fluid.

It can be seen that the position of the first and second connector portions 10 and 12 could be reversed. With the first connector portion 10 located upwardly on the bottom, the protective fluid would of necessity have to be selected having a specific gravity heavier than the well fluid. A fluid having the desired insulating properties and which is heavier than the fluid usually encountered in the wells is carbon tetrafluoride. The illustrated embodiment, however, is preferred.

The illustrated embodiment of FIGURES 3, 4 and 5 is exemplary of the application of the coupling of this invention as a means of making electrical connection in a fluid environment. Many other applications are apparent. In addition, this disclosure illustrates the application of the invention to an arrangement wherein two circuits are competing. It can be seen that the described device can easily be modified to provide three or more electrical connections, such being accomplished, as an example, by additional coaxial tubular connecting portions 16 and 18.

While the invention has been described with a certain degree of particularity, it is manifest that many changes may be made in the details of construction and the arrangement of components without departing from the spirit and scope of this disclosure.

What is claimed:
1. A connector device for making electrical vertical connection in a conducting liquid environment comprising:
   a first connector portion including a vertical liquid containing tubular housing closed at one end, a first tubular contacting element of less diameter and length than said housing coaxially supported within said tubular housing, a second connector portion by puncturing said contacting element of less diameter and length than said first tubular contacting element coaxially supported within said first tubular contacting element; a second connector portion including a vertical cylindrical contacting element;
   an insulating sleeve of length less than said cylindrical element concentrically receiving said cylindrical element and leaving one end thereof exposed, a tubular contacting element of length less than said first cylindrical element coaxially receiving said insulated sleeve and said cylindrical element at the end thereof opposite said exposed end;
   and a rupturable membrane normally closing said open end of said tubular housing, said tubular housing being filled with insulating liquid retained therein by said rupturable membrane, said insulating liquid having a specific gravity different from the specific gravity of said conducting liquid environment whereby said insulating liquid tends to remain in said housing, said first and second contacting portions being vertically movable towards each other whereby said second connector portion extends within said first connector portion.

2. A connector device for making electrical vertical connection in a conducting liquid environment according to claim 1 wherein said rupturable membrane includes a sheet of thin frangible material positioned over the open end of said tubular housing and extending parallel a portion of the exterior of the housing around the full periphery thereof and an extended elastic band positioned over said parallel extending portion constraining said portion against the external peripheral surface of said tubular housing.

3. A connector device for making electrical vertical connection in a conducting liquid environment according to claim 1 wherein said second connector portion extends upwardly, wherein said first connector portion opening is at the lower end thereof and wherein said insulating liquid has a specific gravity less than the specific gravity of the liquid environment in which connection is to be made.

4. A connector device for making electrical vertical connection in a conducting liquid environment according to claim 1 wherein said second connector portion extends downwardly within a conducting liquid environment and wherein said insulating liquid has a specific gravity heavier than the specific gravity of the liquid environment in which connection is to be made.

5. A connector device for making electrical vertical connection in a conducting liquid environment comprising:
   a first connector portion including a vertical liquid containing tubular housing closed at one end; a contacting element of less diameter and length than said first connector portion housing supported within said housing; a second connector portion including a vertical cylindrical contacting element having an exposed contacting end; and a rupturable membrane normally closing said open end of said tubular housing, said tubular housing being filled with insulating liquid retained therein by said rupturable membrane, said insulating liquid having a specific gravity different from that of the liquid
environment whereby said insulating liquid tends to remain in said housing, said first and second contacting portions being vertically movable towards each other whereby said vertical contacting portion of said second connector portion extends within said first connector portion by puncturing said rupturable membrane to displace a portion of said insulating liquid therein and whereby said exposed end of said second connector portion contacting engaging said first connector portion contacting element.

6. A connector device according to claim 5 wherein said rupturable membrane includes a sheet of thin frangible material positioned over the open end of said tubular housing and extending parallel a portion of the exterior of the housing around the full periphery thereof and an extended elastic band positioned over said parallel extending portion constraining said portion against the external peripheral surface of said tubular housing.

7. A connector device for making electrical vertical connection in a conducting liquid environment according to claim 5 wherein said second connector portion extends upwardly, wherein said first connector portion opening is at the lower end thereof and wherein said insulating liquid has a specific gravity less than the specific gravity of the liquid environment in which connection is to be made.

8. A connector for making electrical vertical connection in a conducting liquid environment according to claim 5 wherein said second connector portion extends downwardly within a conducting liquid environment and wherein said insulating liquid has a specific gravity heavier than the specific gravity of the liquid environment in which connection is to be made.